CLAIMS

1. A microelectromechanical (MEMS) switch apparatus comprising:

an anchor attached to a substrate;

an electrically conductive beam attached to the anchor and in electrical contact therewith, the beam comprising:

a tapered portion having a proximal end and a distal end, the proximal end being attached to the anchor,

an actuation portion attached to the distal end of the tapered portion,

a tip attached to the actuation portion, the tip having a contact dimple thereon; and

an actuation electrode attached to the substrate and positioned between the actuation portion and the substrate.

2. The apparatus of claim 1 wherein the tip is attached to the activation portion on the opposite end from where the tapered portion is attached.

3. The apparatus of claim 1 wherein the proximal end of the beam has a greater width than the distal end.

4. The apparatus of claim 1 wherein the beam is comprised of gold (Au).

5. The apparatus of claim 1 wherein the beams are composite beams comprising a plurality of material layers.

6. The apparatus of claim 5 wherein the plurality of layers comprises a structural layer sandwiched between a pair of electrically conductive layers.

7. The apparatus of claim 1 wherein the anchor is connected to ground and the contact dimple contacts a signal line when the actuation electrode is activated.

8. The apparatus of claim 1 wherein the anchor is in electrical contact with a first part of a signal line and the contact dimple can contact a second part of the signal line when the actuation electrode is activated.

9. The apparatus of claim 1 wherein the contact dimple is a first contact dimple, and further comprising a second contact dimple on the tip, wherein the first contact dimple can contact a first part of a signal line and the second contact dimple can contact a second part of the signal line when the actuation electrode is activated.

10. The apparatus of claim 1 wherein the beam is a first beam, and further comprising:

a second anchor attached to the substrate;

a second beam attached to the second anchor and in electrical contact therewith, the second beam comprising:

a tapered portion having a first end and a second end, the first end being attached to the second anchor,

an actuation portion attached to the second end of the tapered portion, and

a tip attached to the actuation portion, the tip having a contact dimple thereon; and;

a second actuation electrode attached to the substrate and positioned between the actuation portion of the second beam and the substrate.

11. The apparatus of claim 10 wherein the first and second anchors are connected to ground and the contact dimples of the first and second tips can contact a signal line when the first and second actuation electrodes are activated.

12. The apparatus of claim 10 wherein the first anchor is in electrical contact with a first part of a signal line, the second anchor is in electrical contact with a second part of a

signal line, and the contact dimple on the tips of the first and second beams can contact a second part of the signal line when the actuation electrode is activated.

13. A microelectromechanical (MEMS) switching apparatus comprising:

a beam array comprising an anchor attached to a substrate and having a plurality of electrically conductive beams connected thereto and in electrical contact therewith, each of the plurality of beams comprising:

a tapered portion having a proximal end and a distal end, the proximal end being attached to the anchor,

an actuation portion attached to the distal end of the tapered portion, and

a tip attached to the actuation portion, the tip having a contact dimple thereon; and

an actuation electrode attached to the substrate and positioned between the substrate and the actuation portion of each beam.

14. The apparatus of claim 13 wherein the tips are attached to the activation portions opposite where the tapered portions are attached.

15. The apparatus of claim 13 wherein the proximal end of each beam has a greater width than the distal end.

16. The apparatus of claim 13 wherein the beams are comprised of gold (Au).

17. The apparatus of claim 13 wherein the beams are composite beams comprising a plurality of material layers.

18. The apparatus of claim 17 wherein the plurality of material layers comprises a structural layer sandwiched between a pair of electrically conductive layers.

19. The apparatus of claim 13 wherein the actuation portion of each beam is joined to the actuation portion of an adjacent beam.

20. The apparatus of claim 13 wherein the anchor is connected to ground and the contact dimples of each beam contact a signal line when the actuation electrode is activated.

21. The apparatus of claim 13 wherein the anchor is in electrical contact with a first part of a signal line and at least one of the contact dimples contacts a second part of the signal line when the actuation electrode is activated.

22. The apparatus of claim 13 wherein the anchor is electrically insulated from the substrate, and wherein the contact dimple of one beam contacts a first part of a signal line and the contact dimple of another beam contacts a second part of a signal line when the actuation electrode is activated.

23. The apparatus of claim 13 wherein the beam array is a first beam array, and further comprising a second beam array comprising:

a second anchor attached to the substrate;

a plurality of electrically conductive beams attached to the second anchor and in electrical contact therewith, each of the plurality of beams comprising:

a tapered portion having a proximal end and a distal end, the proximal end being attached to the anchor,

an actuation portion attached to the distal end of the tapered portion, and

a tip attached to the actuation portion, the tip having a contact dimple thereon; and

an actuation electrode attached to the substrate and positioned between the substrate and the actuation portion of each beam.

24. The apparatus of claim 23 wherein the activation portion of each beam in the second array is joined to the activation portion of an adjacent beam in the second array.

25. The apparatus of claim 23 wherein the first and second anchors are connected to ground and the contact dimples of each beam in the first and second beam arrays can contact a signal line when the first and second actuation electrodes are activated.

26. The apparatus of claim 23 wherein the contact dimples of the first beam array can contact a first portion of a signal line and the contact dimples of the second beam array can contact a second portion of the signal line when the actuation electrodes are activated.

27. A microelectromechanical (MEMS) switch apparatus comprising:

a first anchor and a second anchor, both anchors being attached to a substrate;

an electrically conductive beam attached to the first and second anchors and in electrical contact therewith, the beam comprising:

a first tapered portion having proximal and distal ends, the proximal end being attached to the first anchor,

a second tapered portion having proximal and distal ends, the proximal end being attached to the second anchor, and

a suspended portion connected to the distal end of the first tapered portion and the distal end of the second tapered portion, the suspended portion comprising an actuation portion and a contact portion, each contact portion having a contact dimple thereon; and

an actuation electrode attached to the substrate and positioned between the actuation portion and the substrate.

28. The apparatus of claim 27wherein the beam has a composite construction.

29. The apparatus of claim 28 wherein the beam comprises a layer of a structural material sandwiched between a pair of layers of an electrically conductive material.

30. The apparatus of claim 27 wherein the beam is made of Gold (Au).

31. The apparatus of claim 27 wherein the suspended portion comprises alternating actuation portions and contact portions.

32. The apparatus of claim 31 wherein the actuation portions are substantially wider than the contact portions.

33. The apparatus of claim 27 wherein the first and second anchors are connected to ground and the contact dimple can contact a signal line when the actuation electrodes are activated.

34. The apparatus of claim 27 wherein the beam is a first beam, and further comprising a second beam adjacent the first beam and attached to the first and second anchors, wherein the second beam has the same construction as the first beam.

35. The apparatus of claim 34 wherein the actuation portion of the first beam is connected to the actuation portion of the second beam.

36. The apparatus of claim 34 wherein the contact dimple of the first beam can contact a first portion of a signal line and the contact dimple of the second beam can contact a second portion of the signal line when the actuation electrode is activated.

37. The apparatus of claim 34 wherein the first and second anchors are connected to ground and the contact dimples on the first and second beams can contact a signal line when the actuation electrodes are activated.

38. A microelectromechanical (MEMS) system comprising:

a signal source;

a signal destination connected to the signal source by a signal line; and

a MEMS switch positioned in the signal line, the MEMS switch comprising:

an anchor attached to a substrate;

an electrically conductive beam attached to the anchor and in electrical contact therewith, the beam comprising:

a tapered portion having a proximal end and a distal end, the proximal end being attached to the anchor,

an actuation portion attached to the distal end of the tapered portion,

a tip attached to the actuation portion, the tip having a contact dimple thereon; and

an actuation electrode attached to the substrate and positioned between the actuation portion and the substrate.

39. The system of claim 38 wherein the beam is comprised of gold (Au).

40. The system of claim 38 wherein the beams are composite beams comprising a plurality of material layers.

41. The system of claim 40 wherein the plurality of layers comprises a structural layer sandwiched between a pair of electrically conductive layers.

42. The system of claim 38 wherein the anchor is connected to ground and the contact dimple contacts the signal line when the actuation electrode is activated.

43. The system of claim 38 wherein the anchor is in electrical contact with a first part of the signal line and the contact dimple can contact a second part of the signal line when the actuation electrode is activated.

44. A microelectromechanical (MEMS) system comprising:

a signal source;

a signal destination connected to the signal source by a signal line; and

a MEMS switch positioned in the signal line, the MEMS switch comprising:

a first anchor and a second anchor, both anchors being attached to a substrate;

an electrically conductive beam attached to the first and second anchors and in electrical contact therewith, the beam comprising:

a first tapered portion having proximal and distal ends, the proximal end being attached to the first anchor,

a second tapered portion having proximal and distal ends, the proximal end being attached to the second anchor, and

a suspended portion connected to the distal end of the first tapered portion and the distal end of the second tapered portion, the suspended portion comprising an actuation portion and a contact portion, each contact portion having a contact dimple thereon; and

an actuation electrode attached to the substrate and positioned between the actuation portion and the substrate.

45. The system of claim 44wherein the beam has a composite construction.

46. The system of claim 45 wherein the beam comprises a layer of a structural material sandwiched between a pair of layers of an electrically conductive material.

47. The system of claim 44 wherein the beam is made of Gold (Au).

48. The system of claim 44 wherein the first and second anchors are connected to ground and the contact dimple can contact the signal line when the actuation electrodes are activated.